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TECHNICAL MEMORANDUM

No. W-31/59

INVESTIGATION OF CHAIN IGNITION HAZARDS IN
THE STORAGE OF PACKAGED LIQUID PROPELLANT
SPARROW AND BULLPUP MOTORS IN DEEP AND
READY SERVICE SHIPBOARD MAGAZINES (U)

R. H. Quillin

Weapons Development and Evaluation Laboratory

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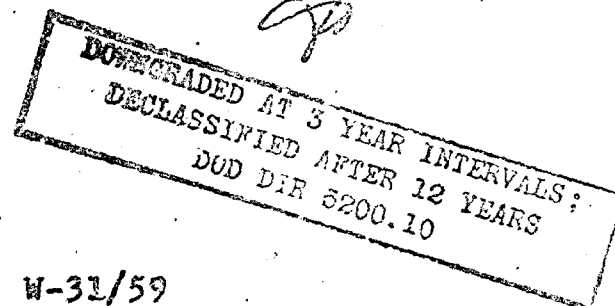
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U. S. NAVAL WEAPONS LABORATORY

TECHNICAL MEMORANDUM

December 1959

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NWL Technical Memorandum No. W-31/59

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- A. Schematic of test set-up to investigate chain ignition from tank punctures
- B. Schematic of test set-up to investigate chain ignition from spurious burning of pressurizing grain

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REFERENCE

(a) NWL Technical Memorandum No. W-4/59 of February 1959

INTRODUCTION

This memorandum proposes additional exploratory tests of the hazard of chain ignitions, normally associated with the multiple stowage of rocket or missile motors in deep or ready service shipboard magazines. Several tests of the packaged liquid propellant Sparrow motor are proposed herein. Should this hazard be proven possible and likely to be encountered in service with this motor, the development of adequate preventive systems or equipment would then be considered.

This proposal is submitted for information and review. It is preliminary in scope and is subject to change until approved by the Bureau of Naval Weapons. After approval, firm dates will be promulgated for set-up check-outs, for tests, and for post test inspections. Attendance on these dates is invited.

BACKGROUND

The Naval Weapons Laboratory is currently investigating chain ignition of the Bullpup, Sparrow and Sidewinder solid propellant motors under shipboard stowage conditions. The basic plan for these tests was presented in reference (a).

With the development of packaged liquid propellant motors for Bullpup and Sparrow missiles, it is appropriate that the likelihood of chain ignitions with these motors also be investigated.

OBJECTIVES

The objectives of the tests proposed herein are to:

a. Determine if chain ignition of packaged liquid propellant Bullpup and Sparrow motors, as stowed in deep or ready service shipboard magazines, is likely.

b. Evaluate the effectiveness of existing magazine sprinkling, detection and venting systems.

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c. Determine the need for additional protective systems or equipment.

d. Evaluate stowage hardware such as clamps and stanchions.

PROCEDURES

Preliminary discussions with cognizant Sections of BUWEPs of the shipboard handling procedures for liquid motors have indicated that the initiator will not be installed in the Sparrow or Bullpup motors while they are in the deep or ready service magazines. The initiator housing opening will not be pressure plugged; therefore, it appears that should an inadvertent burning of a pressurizing grain occur in these magazines, gases and flames will be emitted from the nozzle and the initiator housing opening. Mixing of the oxidizer and fuel will probably not occur or will not occur under normal mixing pressures.

Consequently, in the tests proposed, the possibility of full thrust with normal burning in a magazine has been excluded. Because of the nature of the prepackaged liquid motors, it appears that the data desired may be obtained with relatively few tests. Three tests are proposed and are shown schematically in Appendices A and B.

Test A assumes that the oxidizer and fuel tank of a stowed missile can be punctured simultaneously by a sharp object (fractured stanchion, hand tool, etc.). This test would determine the effects of a resultant fire on other motors and on warheads. In addition, this test would yield information on the effectiveness of the detection, sprinkling and venting systems and on the protection afforded by the initiator housing closure and the nozzle closure. Any influence of ambient magazine pressure and temperature rise on the fuel-oxidizer combustion would also be noted.

Tentatively, it is envisioned that three motors would be included, arranged as shown in Appendix A. Simulated warheads would be attached to two motors. Vertical magazine bulkheads would be included to simulate the corner of a magazine. The two tanks of motor No. 1 would be punctured simultaneously, by a method to be

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devised, along a line traversing the center header. Minimum service stowage distances between motors, between motors and the deck, and between motors and bulkheads would be selected to induce reflective flame impingement on the motors and warheads.

Test B assumes that the ignition of a pressurizing grain is possible by some spurious means (and for purposes of the test, has occurred). The test is designed to determine if the flames and gases produced by ignition of the grain in one motor will ignite the grain in an adjacently stowed motor. It is assumed, for this test, that the most likely avenues for flame or gas impingement on adjacent grains are through the initiator housing opening or through the jet mixing orifices.

Four motors would be positioned in two rows as shown in Appendix B. The pressurizing grain in motor No. 1 would be initiated by a method, to be developed, that would permit flame and gas to exhaust freely through the initiator housing opening. Motor No. 2 would be aligned with motor No. 1, nozzle-to-nozzle. Motor Nos. 1 and 3 would be rotated so that the two initiator housing openings would be aligned and would face each other. Motor No. 4 would be positioned with the booster charge and initiator housing opening toward the nozzle of motor No. 1. The initiator housing opening of motor No. 2 would be directed toward motor No. 4.

Test C would be a repetition of Test A (if warranted) but without the sprinkler system.

EQUIPMENT

The basic equipment to be used is:

a. Simulated Shipboard Magazine

The barbette test magazine described in reference (a) will be used. It is currently being used in the solid propellant investigation. The existing detection, venting and sprinkler systems will be modified as necessary and appropriate for liquid motor stowage.

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b. Stowage Racks

Stowage fittings and racks as described in reference (a) will be used, except that wedge motor clamps will be used.

c. Motor Assemblies

Sparrow motors, XLR44-RM-2 will be used. Seven of these assemblies are currently available at NWL. It is anticipated that 4 to 7 of these motors will be required, depending on the number recoverable from the first test conducted.

d. Warheads

Simulated Sparrow warheads will be attached to two of the motor assemblies. These warheads will be made up by NWL by filling inert warhead metal components with Montan wax.

RECORDED DATA

Recorded data will include:

- a. Magazine pressure history
- b. Magazine temperature history
- c. High fidelity recording of test sound
- d. Color-sound motion pictures of the magazine exterior, taken at 24 fps
- e. Color motion pictures of the motor assemblies, taken at high frame rates
- f. Temperature history of the simulated warheads
- g. Ignition times of pressurizing grains

COST

It is estimated that the cost of the three tests as described will be approximately \$16,000. Portions of this sum will be used to devise an initiation technique; modify detection, sprinkling and venting systems; and provide for personnel safety.

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REPORTING

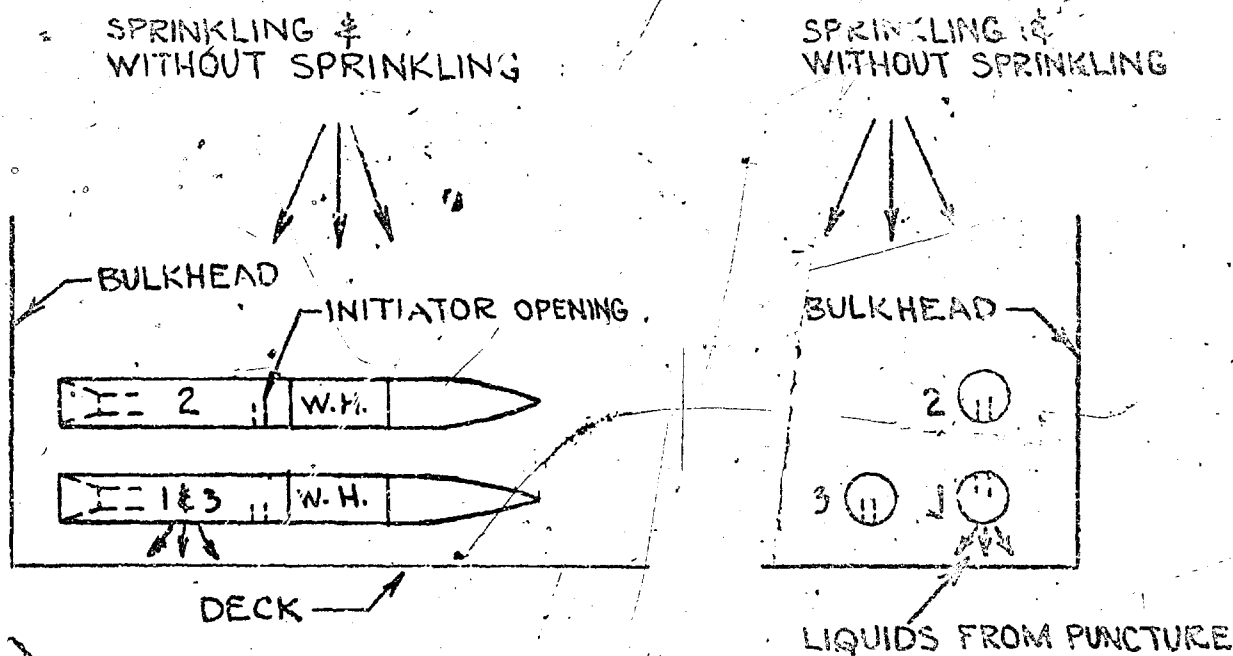
Preliminary reports on each test will be presented at BUWEPS critiques. A formal report will be presented at the end of the investigation.

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APPENDIX A

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APPENDIX A



TEST SET-UP
CHAIN IGNITION FROM TANK PUNCTURES

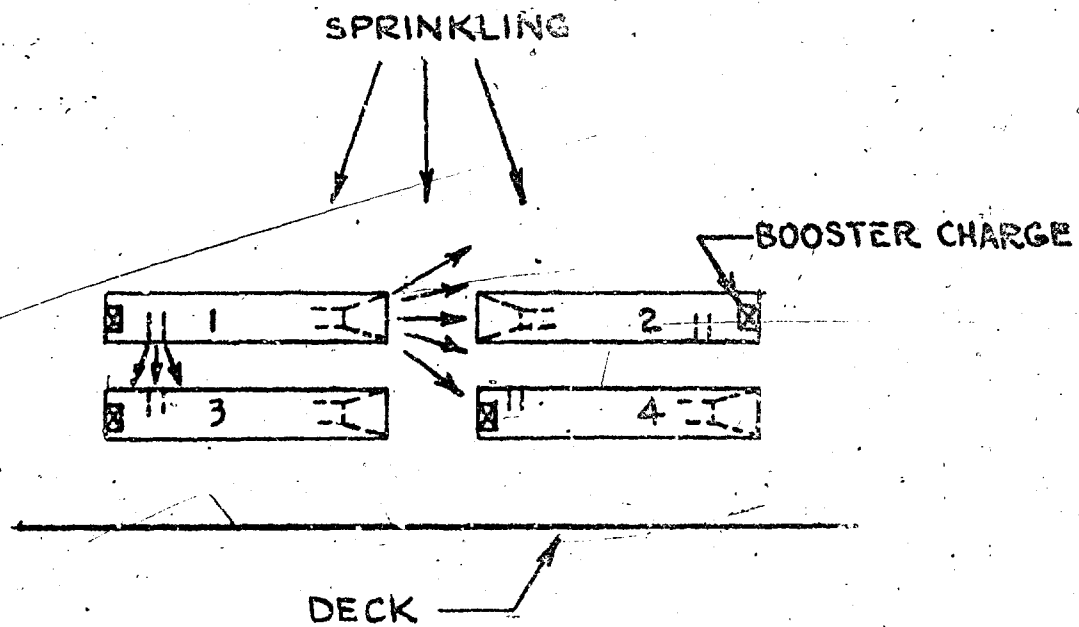
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APPENDIX B

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APPENDIX B



TEST SET-UP
CHAIN IGNITION FROM BURNING
OF PRESSURIZING GRAIN

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